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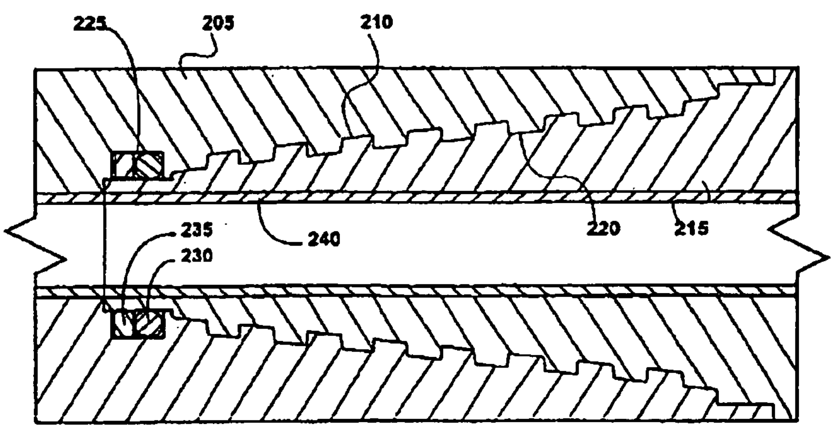

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(57) Abstract: A lubricant coating (240) for expandable tubulars (215). The interior surfaces of the expandable tubulars are coated with the lubricant coating (240). The expandable tubulars (215) are then placed within a preexisting structure (205). The expandable tubulars are then radially expanded into contact with the preexisting structure.

LUBRICANT COATING FOR EXPANDABLE TUBULAR MEMBERS

Background of the Invention

This invention relates generally to coupling at least one tubular member to a preexisting structure. The at least one tubular member may be for example, a wellbore casing, an underground pipe or a structural support. For convenience, the invention will be described hereinafter with reference to wellbore casings.

Conventionally, when a wellbore is created, a number of casings are installed in the borehole to prevent collapse of the borehole wall and to prevent undesired outflow of drilling fluid into the formation or inflow of fluid from the formation into the borehole. The borehole is drilled in intervals whereby a casing which is to be installed in a lower borehole interval is lowered through a previously installed casing of an upper borehole interval. As a consequence of this procedure the casing of the lower interval is of smaller diameter than the casing of the upper interval. Thus, the casings are in a nested arrangement with casing diameters decreasing in downward direction. Cement annuli are provided between the outer surfaces of the casings and the borehole wall to seal the casings from the borehole wall. As a consequence of this nested arrangement a relatively large borehole diameter is required at the upper part of the wellbore. Such a large borehole diameter involves increased costs due to heavy casing handling equipment, large drill bits and increased volumes of drilling fluid and drill cuttings. Moreover, increased drilling rig time is involved due to required cement pumping, cement hardening, required equipment changes due to large variations in hole diameters drilled in the course of the well, and the large volume of cuttings drilled and removed.

The present invention is directed to overcoming one or more of the limitations of the existing procedures for forming wellbores. It has been proposed to form wellbore casings using expandable tubular members, and the present invention is particularly directed to improving methods and apparatus using at least one expandable tubular member.

Summary of the Invention

According to a first aspect of the present invention, a method of coupling an expandable tubular assembly including at least one tubular member to a preexisting

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structure, comprising coating the interior surfaces of the at least one tubular members with a lubricant; positioning the coated at least one tubular member within a preexisting structure; and radially expanding the coated at least one tubular member into contact with the preexisting structure using an expansion cone that engages the coating.

Also according to the first aspect of the present invention, an apparatus is provided that comprises a preexisting structure and at least one tubular member coupled to the preexisting structure by the process of coating the interior surface of the at least one tubular member with a lubricant; positioning the coated at least one tubular member within a preexisting structure; and radially expanding the coated at least one tubular member into contact with the preexisting structure using an expansion cone that engages the coating.

According to a second aspect of the present invention, there is provided a method of coupling an expandable tubular assembly including at least one tubular member to a preexisting structure, comprising coating the interior surface of the at least one tubular member with a first part of a lubricant; positioning the coated at least one tubular member within a preexisting structure; circulating a fluidic material including a second part of the lubricant into contact with the coating of the first part of the lubricant; and radially expanding the coated at least one tubular member into contact with the preexisting structure using an expansion cone that engages the coating.

Also according to the second aspect of the present invention, there is provided apparatus, comprising: a preexisting structure and at least one tubular member coupled to the preexisting structure by the process of coating the interior surface of the at least one tubular member with a first part of a lubricant; positioning the at least one tubular member within a preexisting structure; circulating a fluidic material having a second part of the lubricant into contact with the coating of the first part of the lubricant; and radially expanding the coated at least one tubular member into contact with the preexisting structure using an expansion cone that engages the coating.

Brief Description of the Drawings

Embodiments of the present invention will now be described by way of example only, with reference to the accompanying drawings in whioh:

Fig. 1 is a flow chart illustrating a preferred embodiment of a method for coupling a plurality of tubular members to a preexisting structure.

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Fig. 2 is cross sectional illustration of a plurality of tubular members including in internal coating of a lubricant.

Fig. 3 is a fragmentary cross sectional illustration of the radial expansion of the tubular members of Fig. 2 into contact with a preexisting structure; and

Fig. 4 is a flow chart illustrating an alternative preferred embodiment of a method for coupling a plurality of tubular members to a preexisting structure.

Detailed Description

A method and apparatus for coupling tubular members to a preexisting structure is provided. The internal surfaces of the tubular members are coated with a lubricant. The tubular members are then radially expanded into contact with a preexisting structure. In several alternative embodiments, the method and apparatus are used to form and/or repair a wellbore casing, a pipeline, or a structural support.

In Fig. 1, a preferred embodiment of a method 100 for forming and/or repairing a wellbore casing, pipeline, or structural support includes the steps of: (1) providing one or more tubular members in step 105; (2) applying a lubricant coating to the interior walls of the tubular members in step 110; (3) coupling the first and second tubular members in step 115; and (4) radially expanding the tubular members into contact with the preexisting structure in step 120.

As illustrated in Fig. 2, in a preferred embodiment, in step 105, a first tubular member 205 having a first threaded portion 210 and a second tubular member 215 having a second threaded portion 220 are provided. The first and second tubular members, 205 and 215, may be any number of conventional commercially available tubular members. In a preferred embodiment, the first tubular member 205 includes a recess 225 containing a sealing member 230 and a retaining ring 235. In a preferred embodiment, the first and second tubular members, 205 and 210, are further provided substantially as disclosed in US Patent No. 6,497,289 and Australian Patent No. 767364; Australian Patent No. 770008; Australian Patent No. 771884; US Patent No. 6,328,113; US Patent No. 6,640,903; US Patent No. 6,575,240; US Patent No. 6,557,640 and Australian Patent No. 773168; US Patent No. 6,604,763 and filed as AU 37920/00; Australian Patent No. 776580; US Patent No. 6,564,875; US Patent No. 6,568,471.

In a preferred embodiment, in step 110, a coating 240 of a lubricant is applied to

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the interior surfaces of the first and second tubular members, 205 and 215. The coating 240 of lubricant may be applied prior to, or after, the first and second tubular members, 205 and 215, are coupled. The coating 240 of lubricant may be applied using any number of conventional methods such as, for example, dipping, injecting, spraying, sputter coating or electrostatic deposition. In a preferred embodiment, the coating 240 of lubricant is chemically, mechanically, and/or adhesively bonded to the interior surfaces of the first and second tubular members, 205 and 215, in order to optimally provide a durable and consistent lubricating effect. In a preferred embodiment, the force that bonds the lubricant to the interior surfaces of the first and second tubular members, 205 and 215, is greater than the shear force applied during the radial expansion process.

In a preferred embodiment, the coating 240 of lubricant is applied to the interior surfaces of the first and second tubular members, 205 and 215, by first applying a phenolic primer to the interior surfaces of the first and second tubular members, 205 and 215, and then bonding the coating 240 of lubricant to the phenolic primer using an antifriction paste having the coating 240 of lubricant carried in an epoxy resin. In a preferred embodiment, the antifriction paste includes, in parts by weight, 40-80 epoxy resin, 15-30 molybdenum disulfide, 10-15 graphite, 5-10 aluminum, 5-10 copper, 8-15 alumisilicate, and 5-10 polyethylenepolyamine. In a preferred embodiment, the antifriction paste is provided substantially as disclosed in U.S. Patent No. 4,329,238.

The coating 240 of lubricant may be any number of conventional commercially available lubricants such as, for example, metallic soaps or zinc phosphates. In a preferred embodiment, the coating 240 of lubricant is compatible with conventional water, oil and synthetic base mud formulations. In a preferred embodiment, the coating 240 of lubricant reduces metal-to-metal frictional forces, preferably by about 50%, and provides a coefficient of dynamic friction of between about 0.08 to 0.1 during the radial expansion process. In a preferred embodiment, the coating 240 of lubricant does not increase the toxicity of conventional base mud formulations and will not shear in synthetic mud. In a preferred embodiment, the coating 240 of lubricant is stable for temperatures ranging from about -100 to 500°F (-73 to 260°C). In a preferred embodiment, the coating 240 of lubricant is stable when exposed to shear stresses. In a preferred embodiment, the coating 240 of lubricant is stable for storage periods of up to about 5 years. In a preferred embodiment, the coating 240 of lubricant provides corrosion protection for expandable

tubular members during storage and transport.

In a preferred embodiment, the coating 240 of lubricant includes sodium, calcium, and/or zinc stearates; and/or zinc and/or manganese phosphates; and/or C-Lube-10; and/or C-Phos-58-M; and/or C-Phos-58-R; and/or polytetrafluoroethylene (PTFE); and/or molybdenum disulfide; and/or metallic soaps (stearates, oleates, etc...) in order to optimally provide a coating of lubricant. In a preferred embodiment, the coating 240 of lubricant provides a sliding coefficient of friction less than about 0.20 in order to optimally reduce the force required to radially expand the tubular members, 205 and 215, using an expansion cone.

In a preferred embodiment, in step 115, the first and second tubular members, 205 and 215, are coupled. The first and second tubular members, 205 and 215, may be coupled using a threaded connection, or, alternatively, the first and second tubular members, 205 and 215, may be coupled by welding or brazing. In a preferred embodiment, the first and second tubular members, 205 and 215, are coupled substantially as disclosed in the above US and Australian patent specifications.

As illustrated in Fig. 3, in steps 120, the first and second tubular members 205 and 215 are then positioned within a preexisting structure 505, and radially expanded into contact with the interior walls of the preexisting structure 505 using an expansion cone 510. The tubular members 205 and 215 may be radially expanded into intimate contact with the interior walls of the preexisting structure 505, for example, by: (1) pushing or pulling the expansion cone 510 through the interior of the tubular members 205 and 215; and/or (2) pressurizing the region within the tubular members 205 and 215 behind the expansion cone 510 with a fluid. In a preferred embodiment, one or more sealing members 515 are further provided on the outer surface of the tubular members 205 and 215, in order to optimally seal the interface between the radially expanded tubular members 205 and 215 and the interior walls of the preexisting structure 505.

In a preferred embodiment, the radial expansion of the tubular members 205 and 215 into contact with the interior walls of the preexisting structure 505 is performed substantially as disclosed in one or more of the above US and Australian Patent specification.

As illustrated in Fig. 4, an alternative embodiment of a method 400 for forming and/or repairing a wellbore casing, pipeline, or structural support includes the steps of: (1)

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providing one or more tubular members in step 405; (2) applying a coating including a first part of a lubricant to the interior walls of the tubular members in step 410; (3) coupling the first and second tubular members in step 415; and (4) radially expanding the tubular members into contact with the preexisting structure while also circulating fluidic materials into contact with the interior walls of the tubular members having a second part of the lubricant in step 420.

In a preferred embodiment, in step 410, a coating including a first part of a lubricant is applied to the interior walls of the tubular members, 205 and 215.

In a preferred embodiment, the first part of the lubricant forms a first part of a metallic soap. In an preferred embodiment, the first part of the lubricant coating includes zinc phosphate.

In a preferred embodiment, in step 420, a second part of the lubricant is circulated within a fluidic carrier into contact with the coating of the first part of the lubricant applied to the interior walls of the tubular members, 205 and 215. In a preferred embodiment, the first and second parts react to form a lubricating layer between the interior walls of the tubular members, 205 and 215, and the exterior surface of the expansion cone. In this manner, a lubricating layer is provided in exact concentration, exactly when and where it is needed. Furthermore, because the second part of the lubricant is circulated in a carrier fluid, the dynamic interface between the interior surfaces of the tubular members, 205 and 215, and the exterior surface of the expansion cone 510 is also preferably provided with hydrodynamic lubrication. In a preferred embodiment, the first and second parts of the lubricant react to form a metallic soap. In a preferred embodiment, the second part of the lubricant is sodium, calcium and/or zinc stearate.

In several experimental exemplary embodiments of the methods 100 and 400, the following observations were made regarding lubricant coatings for expandable tubular members:

(1) boundary lubrication with a lubricant coating having high adhesion (high film/shear strength) to the expandable tubular is the single most important lubricant/lubrication process in the radial expansion process;

(2) hydrodynamic lubrication plays a secondary role in the lubrication process;

(3) expandable tubular lubricant coating offers the more reliable and more effective form of boundary lubrication;

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(4) a liquid lubricant viscosity and/or film strength that provides effective, consistent boundary lubrication typically limits the effectiveness of additives for the mud alone to provide the necessary lubrication while maintaining drilling fluid properties (rheology, toxicity);

(5) consistent reductions of 20 to 25 percent in propagation force during the radial expansion process (compared to uncoated expandable tubular control results) were obtained with the following dry film coatings: (1) polytetrafluoroethylene (PTFE), (2) molybdenum disulfide, and (3) metallic soap (stearates), these results are for laboratory tests on one inch dry pipe, in the absence of any drilling fluid;

(6) a 20 to 25 percent reduction in propagation force during the radial expansion process was observed;

(7) synthetic oil muds do not typically provide sufficient, reliable lubrication for uncoated pipe;

(8) the coefficient of friction for expandable tubular lubricant coatings remains essentially constant across a wide temperature range;

(9) the expected application range for expandable tubular casing expansion is between 40° F and 400°F (4 to 204°C), this range is well within the essentially constant range for coefficient of friction for good coatings; and

(10) good extreme pressure boundary lubricants have a characteristic of performing better (lower coefficients of friction) as the load increases, coefficients of friction between 0.02 and 0.08 are reported for some coatings.

In a preferred embodiment, the optimum lubrication for in-situ expandable tubular radial expansion operations using the methods 100 and/or 400 includes a combination of lubrication techniques and lubricants. These can be summarized as follows: (1) extreme pressure lubricants/lubrication techniques; and (2) hydrodynamic lubrication from the fluid in the pipe during expansion.

Extreme pressure lubrication is preferably provided by: (1) liquid extreme pressure lubricants added to the fluid (e.g., drilling fluid, etc) in contact with the internal surface of the expandable tubular during the radial expansion process, and/or (2) solid lubricants added to, or contained within, the fluid in contact with the internal surface of the

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expandable tubular member during the radial expansion process, and/or (3) solid lubricants applied to the internal surface of the expandable tubular member to be radially expanded, and/or (4) combinations of (1), (2) and (3) above.

Liquid extreme pressure lubricant additives preferably work by chemically adhering to or being strongly attracted to the surface of the expandable tubular to be expanded. These types of liquid extreme pressure lubricant additives preferably form a 'film' on the surface of the expandable tubular member. The adhesive strength of this film is preferably greater than the shearing force along the internal surface of the expandable tubular member during the radial expansion process. This adhesive force is referred to as film strength. The film strength can be increased by increasing the viscosity of the fluid. Common viscosifiers, such as polymeric additives, are preferably added to the fluid in contact with the internal surface of the expandable tubular member during the radial expansion process to increase lubrication. In a preferred embodiment, these liquid extreme pressure lubricant additives include one or more of the following: polyacrylamide polymers, AMPS-acrylamide copolymers, modified cellulose derivatives such as, for example, hydroxyethylcellulose, carboxymethylhydroxyethyl cellulose, polyvinyl alcohol polymers, polyvinyl acetate polymers, polyvinyl alcohol/vinyl acetate copolymers, polyvinyl pyrrolidone and copolymers including polyolefins, latexes such as, for example, styrene butadiene latex, urethane latexes, styrene-maleic anhydride copolymers, viscosity index improvers for motor oils such as polyacrylate esters, block copolymers including styrene, isoprene butadiene and ethylene, ethylene acrylic acid copolymers.

In a preferred embodiment, extreme pressure lubrication is provided using solid lubricants that are applied to the internal surface of the expandable tubular member. These solid lubricants can be applied using various conventional methods of applying a film to a surface. In a preferred embodiment, these solid lubricants are applied in a manner that ensures that the solid lubricants remain on the surface of the expandable tubular member during installation and radial expansion of the expandable tubular member. The solid lubricants preferably include one or more of the following: graphite, molybdenum disulfide, lead powder, antimony oxide, poly tetrafluoroethylene (PTFE), or silicone polymers. Furthermore, blends of these solid lubricants are preferred.

In a preferred embodiment, the solid lubricants are applied directly to the expandable tubulars as coatings. The coating of the solid lubricant preferably includes a

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binder to help hold or fix the solid lubricant to the expandable tubular. The binders preferably include curable resins such as, for example, epoxies, acrylic, urea-formaldehyde, melamine formaldehyde, furan based resins, acetone formaldehyde, phenolic, alkyd resins, silicone modified alkyd resins, etc. The binder is preferably selected to withstand the expected temperature range, pH, salinity and fluid types during the installation and radial expansion operations. Polymeric materials are preferably used to bind the solid lubricants to the expandable tubular such as, for example, "self-adhesive" polymers such as those copolymers or terpolymers based upon vinyl acetate, vinyl chloride, maleic anhydride/maleic acid, and ethylene-acrylic acid copolymers, ethylene-methacrylic acid copolymers and ethylene-vinyl acetate copolymers. In an alternative embodiment, the solid lubricants are applied as suspensions of fine particles in a carrier solvent without the presence/use of a chemical binder.

In a preferred embodiment, the solid lubricant coating and the liquid lubricant additive (added to the fluid in contact with the internal surface of the expandable tubular member during the radial expansion process) interact during the radial expansion process to improve the overall lubrication. In an exemplary embodiment, for phosphate solid lubricant coatings, manganese phosphate is preferred over zinc or iron phosphate because it more effectively attracts and retains liquid lubricant additives such as oils, esters, amides, etc.

In a preferred embodiment, solid lubricant coatings use binders that provide low friction that is enhanced under extreme pressure conditions by the presence of the solid lubricant. Preferred solid lubricant coatings includes one or more of the following: graphite, molybdenum disulfide, silicone polymers and polytetrafluoroethylene (PTFE). In a preferred embodiment, blends of these materials are used since each material has lubrication characteristics that optimally work at different stages in the radial expansion process. In a preferred embodiment, a solid, dry film lubricant coating for the internal surface of the expandable tubular includes: (1) 1 to 90 percent solids by volume; (2) more preferably, 5 to 70 percent solids by volume; and (3) most preferably, 15 to 50 percent solids by volume. In a preferred embodiment, the solid lubricants include: (1) 5 to 80 percent graphite; (2) 5 to 80 percent molybdenum disulfide; (3) 1 to 40 percent PTFE; and (4) 1 to 40 percent silicone polymers.

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In several exemplary embodiment, the liquid lubricant additives include one or more of the following: (1) esters including: (a) organic acid esters (preferably fatty acid esters) such as, for example, trimethylol propane, isopropyl, penterithritol, n-butyl, etc.; (b) glycerol tri (acetoxy stearate) and N, N' ethylene bis 12 hydroxystearate and octyl hydroxystearate; (c) phosphate and phosphite such as, for example, butylated triphenyl phosphate and isodiphenyl phosphate; (2) sulfurized natural and synthetic oils; (3) alkanolamides such as, for example, coco diethanolamide; (4) amines and amine salts; (5) olefins and polyolefins; (6) C-8 to C-18 linear alcohols and derivatives containing or consisting of esters, amines, carboxylates, etc.; (7) overbased sulfonates such as, for example, calcium sulfonate, sodium sulfonate, magnesium sulfonate; (8) polyethylene glycols; (9) silicones and siloxanes such as, for example, dimethylpolysiloxanes and fluorosilicone derivatives; (10) dinonyl phenols; and (11) ethylene oxide/propylene oxide block copolymers.

Where a liquid lubricant is injected into contact with the expandable tubular assembly, the liquid lubricant material may be selected from: polyacrylamide polymers, AMPS-acrylamide copolymers, modified cellulose derivatives, hydroxyethylcellulose, carboxymethyl hydroxyethyl cellulose, polyvinyl alcohol polymers, polyvinyl acetate polymers, polyvinyl alcohol/vinyl acetate copolymers, polyvinyl pyrrolidone, copolymers including polyolefins, latexes, styrene butadiene latex, urethane latexes, styrene-maleic anhydride copolymers, viscosity index improvers for motor oils, polyacrylate esters, block copolymers including styrene, isoprene butadiene and ethylene, ethylene acrylic acid copolymers, esters, organic acid esters, trimethylol propane, isopropyl, penterithritol, n-butyl, glycerol triacetoxy stearate, N,N' ethylene bis 12 hydroxystearate, octyl hydroxystearate, phosphate, phosphite, butylated triphenyl phosphate, isodiphenyl phosphate, sulfurized natural oils, synthetic oils, alkanolamides, coco diethanolamide, amines, amine salts, olefins, polyolefins, C-8 to C-18 linear alcohols and derivatives including esters, amines, carboxylates, overbased sulfonates, calcium sulfonate, sodium sulfonate, magnesium sulfonate, polyethylene glycols, silicones, siloxanes, dimethylpolysiloxanes, fluorosilicone derivatives, dinonyl phenols, and ethylene oxide/propylene oxide block copolymers. In a preferred embodiment, the injected lubricant material includes a solid lubricant material. In a preferred embodiment, the solid lubricant material is selected from the group consisting of: graphite, molybdenum

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disulfide, lead powder, antimony oxide, poly tetrafluoroethylene, and silicone polymers. In a preferred embodiment, the method further includes: coating the interior surfaces of the tubular members with a lubricant prior to positioning the tubular members within the preexisting structure. In a preferred embodiment, the lubricant coating includes a first part of a lubricating substance; and the injected lubricating material includes a second part of the lubricating substance.

A method of coupling an expandable tubular assembly including one or more tubular members to a preexisting structure has been described that includes: coating the interior surfaces of the tubular members with a first part of a lubricant, positioning the tubular members within a preexisting structure, circulating a fluidic material including a second part of the lubricant into contact with the coating of the first part of the lubricant, and radially expanding the tubular members into contact with the preexisting structure. In a preferred embodiment, the lubricant includes a metallic soap. In a preferred embodiment, the lubricant is selected from the group consisting of sodium, calcium, and/or zinc stearates, zinc phosphates, manganese phosphate, C-Lube-10, C-PHOS-58-M, and C-PHOS-58-R. In a preferred embodiment, the lubricant provides a sliding friction coefficient of less than about 0.20. In a preferred embodiment, the first part of the lubricant is chemically bonded to the interior surfaces of the tubular members. In a preferred embodiment, the first part of the lubricant is mechanically bonded to the interior surfaces of the tubular members. In a preferred embodiment, the first part of the lubricant is adhesively bonded to the interior surface of the tubular members. In a preferred embodiment, the method further includes: combining the first and second parts of the lubricant to generate the lubricant.

Apparatus has been described that includes a preexisting structure and one or more tubular members coupled to the preexisting structure. The tubular members are coupled to the preexisting structure by the process of: coating the interior surfaces of the tubular members with a first part of a lubricant, positioning the tubular members within a preexisting structure, circulating a fluidic materials having a second part of the lubricant into contact with the coating of the first part of the lubricant, and radially expanding the tubular members into contact with the preexisting structure. In a preferred embodiment, the lubricant includes a metallic soap. In a preferred embodiment, the lubricant is selected from the group consisting of sodium, calcium, and/or zinc stearates, zinc phosphates,

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manganese phosphate, C-Lube-10, C-PHOS-58-M, and C-PHOS-58-R. In a preferred embodiment, the lubricant provides a sliding friction coefficient of less than about 0.20. In a preferred embodiment, the first part of the lubricant is chemically bonded to the interior surfaces of the tubular members. In a preferred embodiment, the first part of the lubricant is mechanically bonded to the interior surfaces of the tubular members. In a preferred embodiment, the first part of the lubricant is adhesively bonded to the interior surface of the tubular members. In a preferred embodiment, the apparatus further includes combining the first and second parts of the lubricant to generate the lubricant.

Although this detailed description has shown and described illustrative embodiments of the invention, this description contemplates a wide range of modifications, changes, and substitutions. In some instances, one may employ some features of the present invention without a corresponding use of the other features. Accordingly, it is appropriate that readers should construe the appended claims broadly, and in a manner consistent with the scope of the invention.

The reference to any prior art in this specification is not, and should not be taken as, an acknowledgment or any form of suggestion that that prior art forms part of the common general knowledge in Australia.

Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method of coupling an expandable tubular assembly including at least one tubular member to a preexisting structure, comprising:
coating the interior surface of the at least one tubular member with a lubricant;
positioning the coated at least one tubular member within a preexisting structure; and
radially expanding the coated at least one tubular member into contact with the preexisting structure using an expansion cone that engages the coating.

2. A method of coupling an expandable tubular assembly including at least one tubular member to a preexisting structure, comprising:
coating the interior surface of the at least one tubular member with a first part of a lubricant;
positioning the coated at least one tubular member within a preexisting structure;
circulating a fluidic material including a second part of the lubricant into contact with the coating of the first part of the lubricant; and
radially expanding the coated at least one tubular member into contact with the preexisting structure using an expansion cone that engages the coating.

3. The method of claim 1 or 2, wherein the at least one tubular member comprises a wellbore casing.

4. The method of claim 1 or 2, wherein the at least one tubular member comprises an underground pipe.

5. The method of claim 1 or 2, wherein the at least one tubular member comprises a structural support.

6. The method of claim 1, wherein the coating of lubricant is chemically bonded to the interior surface of the at least one tubular member.

7. The method of claim 1, wherein the coating of lubricant is mechanically bonded to the interior surface of the at least one tubular member.

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8. The method of claim 1, wherein the coating of lubricant is adhesively bonded to the interior surface of the at least one tubular member.

9. The method of claim 1, wherein the coating of lubricant includes:
a primer coating coupled to the interior surface of the at least one tubular member; and
a coating of an antifriction paste coupled to the primer.

10. The method of claim 1, wherein the coating of lubricant includes, in parts by weight:
40-80 epoxy resin, 15-30 molybdenum disulfide, 10-15 graphite, 5-10 aluminum, 5-10 copper, 8-15 alumisilicate, and 5-10 polyethylenepolyamine.

11. The method of claim 1 or 2, wherein the lubricant comprises a metallic soap.

12. The method of claim 1 or 2, wherein the lubricant comprises zinc phosphate.

13. The method of claim 1 or 2, wherein the lubricant provides a coefficient of dynamic friction of between about 0.08 to 0.1.

14. The method of claim 1 or 2, wherein the lubricant comprises one or more of:
sodium stearates, calcium stearates, zinc stearates, zinc phosphate, manganese phosphate, C-Lube-10, C-Phos-58-M, C-Phos-58-R, polytetrafluoroethylene, molybdenum disulfide, and metallic soaps.

15. The method of claim 1 or 2, wherein the lubricant provides a sliding coefficient of friction less than about 0.20.

16. The method of claim 1 or 2, wherein the lubricant comprises one or more of:
polyacrylamide polymers, AMPS-acrylamide copolymers, modified cellulose derivatives, hydroxyethylcellulose, carboxymethyl hydroxyethyl cellulose, polyvinyl alcohol polymers, polyvinyl acetate polymers, polyvinyl alcohol acetate copolymers, polyvinyl vinyl acetate copolymers, polyvinyl pyrrolidone and copolymers including polyolefins, latexes, styrene butadiene latex, urethane

latexes, styrene-maleic anhydride copolymers, viscosity index improvers for motor oils, polyacrylate esters, block copolymers including styrene, block copolymers including isoprene butadiene, block copolymers including ethylene, and ethylene acrylic acid copolymers.

17. The method of claim 1 or 2, wherein the lubricant comprises one or more of: graphite, molybdenum disulfide, lead powder, antimony oxide, poly tetrafluoroethylene, and silicone polymers.

18. The method of claim 1, wherein the coating of lubricant comprises:
a solid lubricant; and
a binder.

19. The method of claim 18, wherein the binder is selected from:
epoxy, acrylic, urea-formaldehyde, melamine formaldehyde, furan based resin, acetane formaldehyde, phenolic, alkyd resins, and silicone modified alkyd resin.

20. The method of claim 18, wherein the binder is selected from:
vinyl acetate, vinyl chloride, maleic anhydride, maleic acid, ethylene-acrylic acid copolymers, ethylene-methacrylic acid copolymers, and ethylene-vinyl acetate copolymers.

21. The method of claim 1 or 2, wherein the lubricant comprises a suspension of particles in a carrier solvent.

22. The method of claim 1 or 2, wherein the lubricant comprises one or more of:
manganese phosphate, zinc phosphate, and iron phosphate.

23. The method of claim 1 or 2, wherein the lubricant comprises:
about 1 to 90 percent solids by volume.

24. The method of claim 23, wherein the lubricant comprises:
about 5 to 70 percent solids by volume.

25. The method of claim 24, wherein the lubricant comprises:
about 15 to 50 percent solids by volume.

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26. The method of claim 1 or 2, wherein the lubricant comprises:
about 5 to 80 percent graphite;
about 5 to 80 percent molybdenum disulfide;
about 1 to 40 percent PTFE; and
about 1 to 40 percent silicone polymers.

27. The method of claim 1 or 2, wherein the lubricant comprises one or more of:
ester;
sulfurized oil;
alkanolamides;
amine;
amine salt;
olefin;
polyolefins;
C-8 to C-18 linear alcohol;
derivative of C-8 to C-18 linear alcohol including ester;
derivative of C-8 to C-18 linear alcohol including amine;
derivative of C-8 to C-18 linear alcohol including carboxylate;
sulfonate;
polyethylene glycol;
silicone;
siloxane;
dinonyl phenol;
ethylene oxide block copolymer; and
propylene oxide block copolymer.

28. Apparatus, comprising:
a preexisting structure; and
at least one tubular member coupled to the preexisting structure by the process of:
coating the interior surface of the at least one tubular member with a lubricant;
positioning the coated at least one tubular member within a preexisting structure; and
radially expanding the coated at least one tubular member into contact with the

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preexisting structure using an expansion cone that engages the coating.

29. Apparatus, comprising:
a preexisting structure; and
at least one tubular member coupled to the preexisting structure by the process of:
coating the interior surface of the at least one tubular member with a first part of a lubricant;
positioning the at least one tubular member within a preexisting structure;
circulating a fluidic material having a second part of the lubricant into contact with the coating of the first part of the lubricant; and
radially expanding the coated at least one tubular member into contact with the preexisting structure using an expansion cone that engages the coating.

30. The apparatus of claim 28 or 29, wherein the at least one tubular member comprises a wellbore casing.

31. The apparatus of claim 28 or 29, wherein the at least one tubular member comprises an underground pipe.

32. The apparatus of claim 28 or 29, wherein the at least one tubular member comprises a structural support.

33. The apparatus of claim 28, wherein the coating of lubricant is chemically bonded to the interior surface of the at least one tubular member.

34. The apparatus of claim 28, wherein the coating of lubricant is mechanically bonded to the interior surface of the at least one tubular member.

35. The apparatus of claim 28, wherein the coating of lubricant is adhesively bonded to the interior surface of the at least one tubular member.

36. The apparatus of claim 28, wherein the coating of lubricant includes:
a primer coating coupled to the interior surface of the at least one tubular member; and
a coating of an antifriction paste coupled to the primer.

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37. The apparatus of claim 28, wherein the coating of lubricant includes, in parts by weight:
40-80 epoxy resin, 15-30 molybdenum disulfide, 10-15 graphite, 5-10 aluminum, 5-10 copper, 8-15 alumisilicate, and 5-10 polyethylenepolyamine.

38. The apparatus of claim 28 or 29, wherein the lubricant comprises a metallic soap.

39. The apparatus of claim 28 or 29, wherein the lubricant comprises zinc phosphate.

40. The apparatus of claim 28 or 29, wherein the lubricant provides a coefficient of dynamic friction of between about 0.08 to 0.1.

41. The apparatus of claim 28 or 29, wherein the lubricant comprises one or more of: sodium stearates, calcium stearates, zinc stearates, zinc phosphate, manganese phosphate, C-Lube-10, C-Phos-58-M, C-Phos-58-R, polytetrafluoroethylene, molybdenum disulfide, and metallic soaps.

42. The apparatus of claim 28 or 29, wherein the lubricant provides a sliding coefficient of friction less than about 0.20.

43. The apparatus of claim 28 or 29, wherein the lubricant comprises one or more of: polyacrylamide polymers, AMPS-acrylamide copolymers, modified cellulose derivatives, hydroxyethylcellulose, carboxymethyl hydroxyethyl cellulose, polyvinyl alcohol polymers, polyvinyl acetate polymers, polyvinyl alcohol acetate copolymers, polyvinyl vinyl acetate copolymers, polyvinyl pyrrolidone and copolymers including polyolefins, latexes, styrene butadiene latex, urethane latexes, styrene-maleic anhydride copolymers, viscosity index improvers for motor oils, polyacrylate esters, block copolymers including styrene, block copolymers including isoprene butadiene, block copolymers including ethylene, and ethylene acrylic acid copolymers.

44. The apparatus of claim 28 or 29, wherein the lubricant comprises one or more of: graphite, molybdenum disulfide, lead powder, antimony oxide, poly tetrafluoroethylene, and silicone polymers.

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45. The apparatus of claim 28, wherein the coating of lubricant comprises:
a solid lubricant; and
a binder.

46. The apparatus of claim 45, wherein the binder is selected from:
epoxy, acrylic, urea-formaldehyde, melamine formaldehyde, furan based resin, acetone formaldehyde, phenolic, alkyd resins, and silicone modified alkyd resin.

47. The apparatus of claim 45, wherein the binder is selected from:
vinyl acetate, vinyl chloride, maleic annhydride, maleic acid, ethylene-acrylic acid copolymers, ethylene-methacrylic acid copolymers, and ethylene-vinyl acetate copolymers.

48. The apparatus of claim 28 or 29, wherein the lubricant comprises a suspension of particles in a carrier solvent.

49. The apparatus of claim 28 or 29, wherein the lubricant comprises one or more of:
manganese phosphate, zinc phosphate, and iron phosphate.

50. The apparatus of claim 28 or 29, wherein the lubricant comprises:
about 1 to 90 percent solids by volume.

51. The apparatus of claim 50, wherein the lubricant comprises:
about 5 to 70 percent solids by volume.

52. The apparatus of claim 51, wherein the lubricant comprises:
about 15 to 50 percent solids by volume.

53. The apparatus of claim 28 or 29, wherein the lubricant comprises:
about 5 to 80 percent graphite;
about 5 to 80 percent molybdenum disulfide;
about 1 to 40 percent PTFE; and
about 1 to 40 percent silicone polymers.

54. The apparatus of claim 28 or 29, wherein the lubricant comprises one or more of the following:

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ester;
sulfurized oil;
alkanolamides;
amine;
amine salt;
olefin;
polyolefins;
C-8 to C-18 linear alcohol;
derivative of C-8 to C-18 linear alcohol including ester;
derivative of C-8 to C-18 linear alcohol including amine;
derivative of C-8 to C-18 linear alcohol including carboxylate;
sulfonate;
polyethylene glycol;
silicone;
siloxane;
dinonyl phenol;
ethylene oxide block copolymer; and
propylene oxide block copolymer.

55. A method of coupling an expandable tubular assembly including at least one tubular member to a preexisting structure, the method being according to claim 1 or 2, substantially as hereinbefore described with reference to the accompanying drawings.

56. Apparatus according to claim 28 or 29, substantially as hereinbefore described with reference to the accompanying drawings.

DATED this 20th day of July, 2005
Shell Internationale Research Maatschappij B.V.
By DAVIES COLLISON CAVE
Patent Attorneys for the Applicant

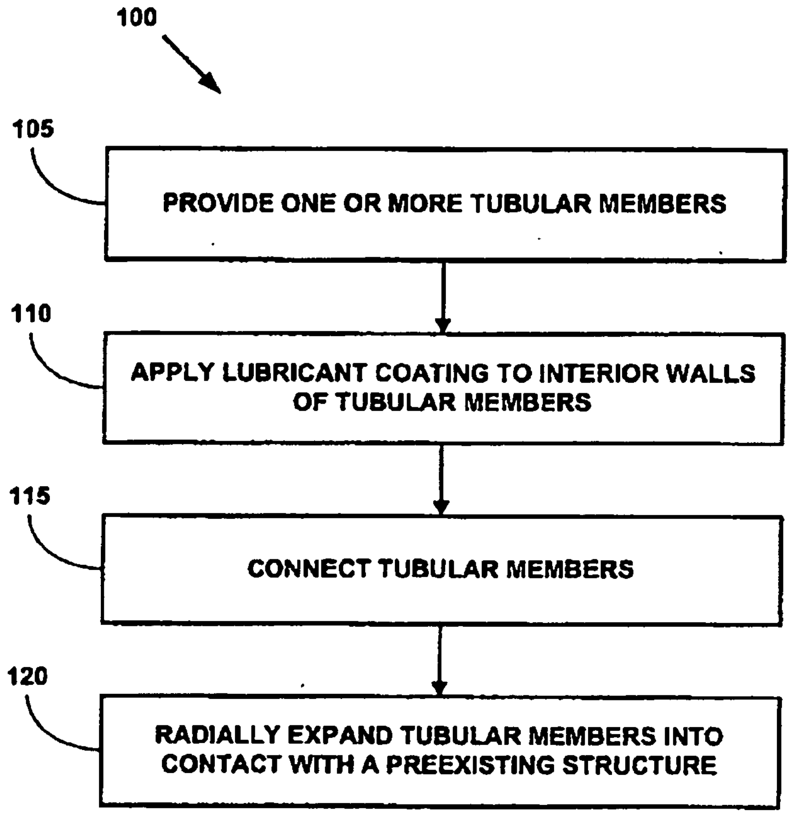
100
105
PROVIDE ONE OR MORE TUBULAR MEMBERS
110
APPLY LUBRICANT COATING TO INTERIOR WALLS OF TUBULAR MEMBERS
115
CONNECT TUBULAR MEMBERS
120
RADIALLY EXPAND TUBULAR MEMBERS INTO CONTACT WITH A PREEXISTING STRUCTURE

FIGURE 1

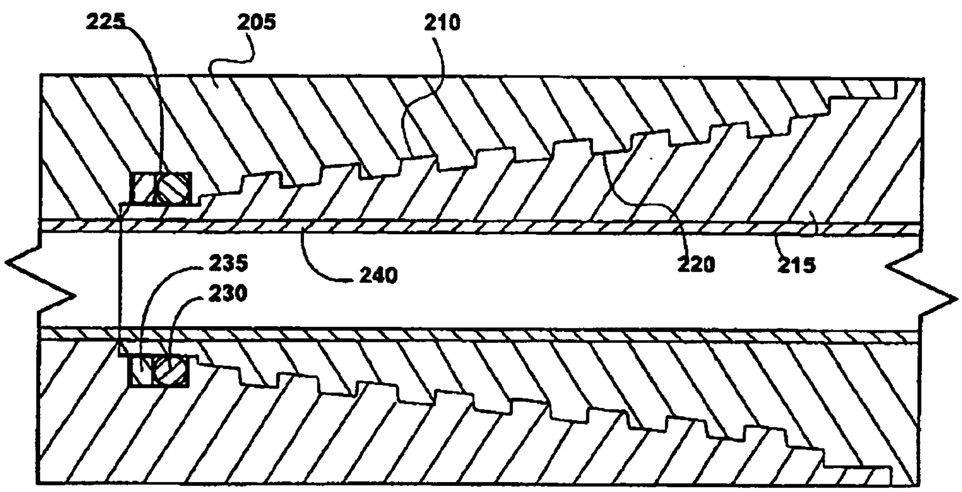

FIGURE 2

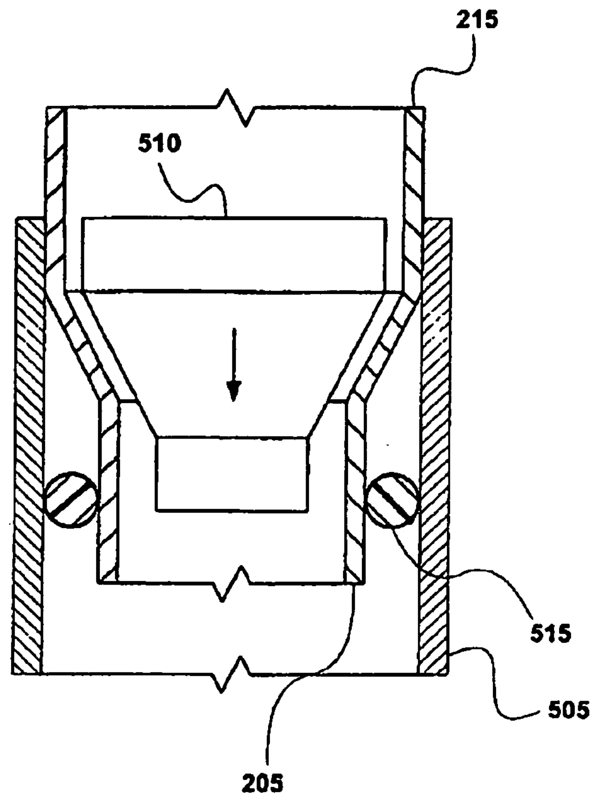

FIGURE 3

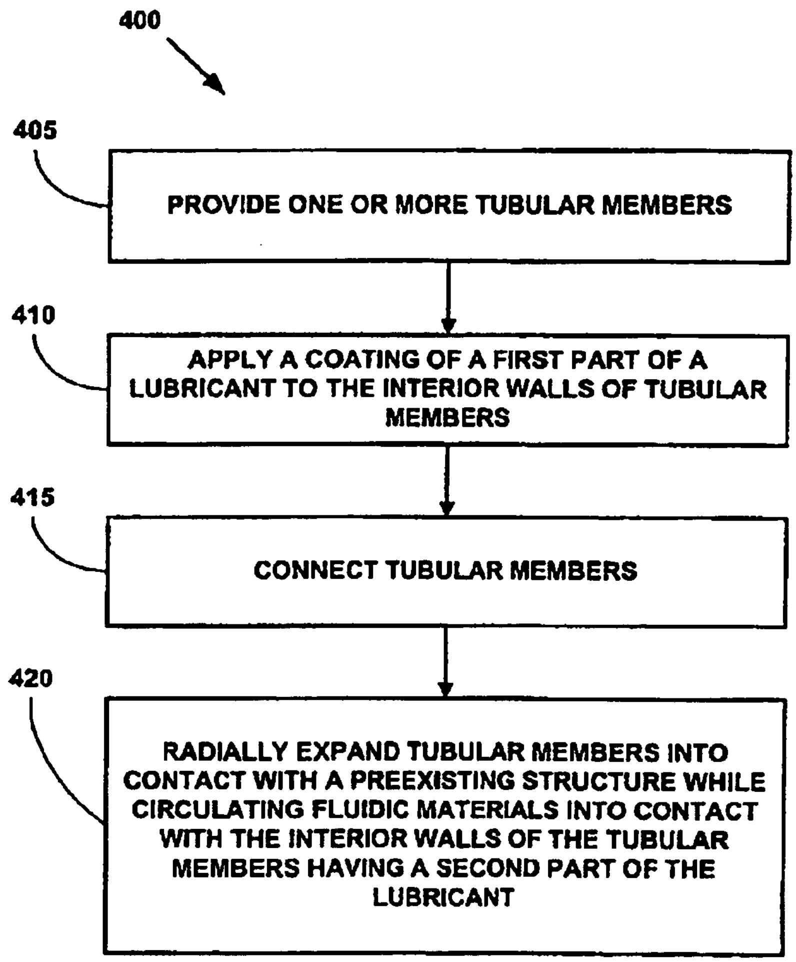
400
405
PROVIDE ONE OR MORE TUBULAR MEMBERS
410
APPLY A COATING OF A FIRST PART OF A LUBRICANT TO THE INTERIOR WALLS OF TUBULAR MEMBERS
415
CONNECT TUBULAR MEMBERS
420
RADIALLY EXPAND TUBULAR MEMBERS INTO CONTACT WITH A PREEXISTING STRUCTURE WHILE CIRCULATING FLUIDIC MATERIALS INTO CONTACT WITH THE INTERIOR WALLS OF THE TUBULAR MEMBERS HAVING A SECOND PART OF THE LUBRICANT

FIGURE 4